DISTRIBUTION AND ABUNDANCE OF COHO AND STEELHEAD IN REDWOOD CREEK IN NOVEMBER 1996

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ABSTRACT. Despite heavy winter and late spring storms, coho density in Redwood Creek in 1996 was similar to 1992, 1993 and 1995. Storms did cause some changes in channel configuration and apparently dispersed coho fry downstream, resulting in a more even distribution of fish. Steelhead densities were similar to those of previous dry years (1992 and 1994) and substantially less than wet years (1993 and 1995). Very low population mortality occurred due to sampling by electroshocker.

INTRODUCTION

Previous electroshock sampling on Redwood Creek in 1988 (Hofstra and Anderson 1989), 1992, 1993, 1994 and 1995 (Smith 1994a; 1994c; 1995a) has shown very strong coho (Oncorhynchus kisutch) year classes in 1992, 1993 and 1995 and weak year classes in 1988 and 1994. Similar pronounced variation among year classes has also been shown for Waddell and Scott creeks in Santa Cruz County (Smith 1994b). Wild female coho are exclusively three year olds (Shapovalov and Taft 1954), so weak or strong year classes will tend to repeat in subsequent three year cycles, if not extirpated or reduced by severe storms or droughts. Therefore, a strong year class was likely in 1996, but a very weak one is expected in 1997.

The existence of missing or weak year classes appears to be due to severe droughts, which block adult or smolt migration, or to severe floods, which destroy most spawning redds (Smith 1994b). Heavy flooding occurred on some central California streams in 1995-96, and a late storm (May) could possibly have reduced coho fry abundance or altered distribution within the watershed. Therefore, three previously sampled sites on Redwood Creek were resampled on 2 November 1996 to determine coho and steelhead (O. mykiss) abundance.

METHODS

Electroshock sampling was conducted on three Redwood Creek sites which had previously been sampled in each year from 1992 to 1995 (Table 1). A fourth regularly sampled site, downstream near Muir Beach, was not sampled, due to lack of time. At each site most of the same individual pool, glide, run and riffle habitats were sampled, although a disjunct portion of the upper site was not sampled. Changes in channel configuration resulted in some changes in habitats sampled among years, but the habitats at each site (Table 1), and overall (Table 2), were generally similar to previous years.

Individual habitats or habitat units (i.e. continuous glide/pool sequence) were block-netted and sampled with 2-3 passes with a backpack electroshocker (Smith-Root, Type 7). Captured fish were immediately placed in a floating live car to speed recovery; any fish killed by sampling were noted. Salmonids were measured in 5 mm increments (standard length) and released. Steelhead young-of-year (YOY) were distinguished from yearlings and older fish by length/frequency at each site. Sampled habitats were habitat typed, and depths and cover ratings determined.

Small portions (2x2 mm) of the caudal fin were removed from a total of 45 coho from Sites 2 and 6 and placed in buffered vials. Vials were placed on ice and later placed in a -80 degree freezer at San Jose State University. Samples will be transferred to the California Department of Fish and Game genetic collection for future DNA analysis.

RESULTS AND DISCUSSION

Channel Effects of 1996 Storms

Although total winter runoff in 1995-96 was less than in 1994-95, effects on channel configuration appeared to be more pronounced. At site 5 there were substantial changes in the configuration of individual pool/riffle sequences, and the change in sampled habitats (Table 1) reflects the change in stream configuration, rather than a change in the location of sampling units. At Site 6 the depths of the generally shallow pools significantly increased. Changes were minor at the sampled portion of Site 2, but a pool at the disjunct portion was filled.

Coho

Overall coho density in 1996 (39 per 100 feet) was slightly lower than that found in 1992, 1993, and 1995 (42-46 per 100 feet) (Table 2), which may partially reflect later sampling in 1996. However, the distribution of coho varied substantially among years. In the first two years densities were dramatically higher at the uppermost site (Muir Woods) (Table 1). However, in 1995 and 1996 abundances at Muir Woods (45 and 37 per 100 feet) were about half of 1992 and 1993 (84 and 91 per 100 feet), and abundance was more even among sites (26-51 per 100 feet) (Table 1). The lowest abundance of coho in all years was at the downstream site, which has generally shallower pools (Table 1) and was subject to severe pumping impacts in 1992.

Steelhead

YOY steelhead densities varied substantially from year to year (Table 2). Overall density in 1996 (33 per 100 feet) was similar to 1992 (23 per 100 feet) and 1994 (34 per 100 feet) (Table 2), but in those years pumping eliminated most fish at site 6. Overall density was substantially less than in 1993 (56 per 100 feet) and 1995 (97 per 100 feet), when summer stream flows were high. YOY sizes were similar to those of 1995 and substantially greater than those of 1994, which had low summer streamflows (Figure 1).

Yearling steelhead were about twice as abundant overall in 1996 (11 per 100 feet) as in other years (4-6 per 100 feet) (Table 2), due to higher abundances at sites 5 and 6 (Table 1).

Sampling Mortality

Four hundred and seventy-three salmonids were captured by backpack electroshocker in 1996, including 214 coho (Table 3). Two coho were killed by sampling (0.9 percent mortality for coho, 0.4% overall).

DISCUSSION

Overall density of coho has been remarkably consistent (39-46 per 100 feet) in all years except the very weak 1988, (1991), 1994 brood year cycle. Much of the coho spawning is apparently concentrated at upstream sites (Mia Monroe and Darren Fong, pers, comm.). However, in some years of heavy winter and spring storms (1995, 1996) coho fry apparently disperse downstream, resulting in a more even distribution of coho compared to dry years (1992) and to wet years without late severe storms (1993).

Coho abundance at Site 6 was lower in 1993, 1995 and 1996 than at other sites, but was still substantial. This site is subject to impacts from pumping in drought years (Smith 1994c).

The relatively low YOY steelhead densities in 1996 at least partially reflect the lateness of sampling, as small steelhead progressively decline in abundance as streamflows and food availability decline over summer and fall (see 1994 data and Smith 1994a and 1994c). Steelhead rear in runs and riffles, which change substantially in depth and velocity with streamflow. Therefore, steelhead should respond more to seasonal and year to year changes in dry season flows than do coho, which prefer pools. Steelhead densities were high in 1993 and 1995, when flows remained relatively high all summer. In drier years (1992, 1994, 1996) steelhead are forced into pools and glides, where they face stiff competition from pool-adapted coho.

The much higher yearling steelhead abundance in 1996 is probably a result of the very high YOY abundance in 1995; yearling abundance overall and at individual sites generally reflects the previous year's abundance of YOY steelhead (Tables 1,2).

Management <u>Implications</u>

In winter 1996-97 few adult coho are expected to return from the very weak 1994 year class (Table 2). The year class is at risk of extirpation, and its success should be monitored by sampling in early fall 1997. In weak year classes the few fish may be in scattered clusters (Smith 1994a and 1994b), so additional sites should be added, if necessary, to confirm the presence of a 1997 year class. Sampling by electrofishing can result in some mortality, but the overall impact can be small. In 1996 coho mortality was 0.9 %, but substantially less than 5 % of the habitat was sampled, so less than 0.05 % of the coho population was lost. It appears that mortality is less when water temperatures are low, so delaying sampling until mid-September or later would keep mortality to a minimum. The approximate sampling period for future sampling should be standarized to improve the comparability for steelhead abundances, which decline as the season progresses.

Coho and yearling steelhead in Redwood Creek primarily occupy pools for rearing, so increasing pools and complex escape cover with large (long and thick) logs would increase average densities (especially at Muir Woods and at Site 6). However, peak storm runoff easily moves small, unanchored woody debris. Significant benefit would come only from large logs, well-anchored on the bank; either most of the log should sit above bank-full runoff or else the log should be artificially anchored.

Steelhead in Redwood Creek fluctuate substantially from year to year with streamflow, and possibly with coho abundance. The flexible life history of steelhead, including extended spawning period, variable age of maturity and multiple spawning attempts (Shapovalov and Taft 1954), means that they are less affected by, and can rapidly recover from, droughts and floods. The steelhead population of Redwood Creek is healthy and at low long-term risk of decline.

Coho have a rigid life history, with short spawning period in early winter, maturation of all wild females at 3 years old, and a single spawning attempt (Shapovalov and Taft 1954). Although 2 of 3 brood years (1992/1995 and 1993/1996) in Redwood Creek are doing very well, the third (1988/1994) is extremely weak, and at risk of extirpation. That brood year can only slowly rebuild from such a low base, and only if conditions are suitable; a severe flood or drought could eliminate that brood year. Artificially rebuilding the brood year with fish from Lagunitas Creek, where the year class is strong, is not desirable, as Lagunitas Creek has received plants of Northern California coho as recently as the 1980's. Another option is hatchery rearing of some Redwood Creek fish to a very large size before release; a portion of these large fish will mature precocially as 2-year olds and help to rebuid the weak year class. At Scott and

Waddell creeks in Santa Cruz County return of hatchery-reared 2-year old females in 1995 rebuilt a weak year class on Scott Creek and may have prevented the loss of a very weak year class on Waddell Creek (Smith 1995b). Hatchery rearing of some Redwood Creek coho in 1998 could be used to reinforce the expected weak production of the 1997 year class.

Although severe floods can probably reduce coho spawning success in some years, the major threat to Redwood Creek salmonids is probably severe drought, along with water pumping. The most likely reason for the weak coho years classes in 1988 and 1994 is the residual effect of the severe 1976-1977 drought (although the January 1982 flood may also be a factor). Low streamflows, aggravated by domestic and agricultural water use would have severely restricted access, spawning and rearing in 1976 and also outmigration of the smolts in Spring 1977. The termination of agricultural diversions near the mouth and upstream on Redwood Creek has probably significantly reduced drought/pumping impacts. However, domestic pumping can still have substantial impact in drought years. Since the effects would be felt mostly in the downstream portion of the watershed (Smith 1994c), passage for smolts in April and May of drought years is probably the most critical water issue.

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Table 1. Density estimates (number of fish per 100 feet) for coho and steelhead collected on Redwood Creek at the three sites sampled in each year from 1992 through 1996.

Site	Sample Date	Habitat Types Sampled				Length Sampled (feet)	Density		
		Pol	Gld	Run	Rif		Coho	Steelhead 0+	Steelhead 1/2+
2. Lower Muir Woods (Miles 2.5 & 2.8)	20 Aug 92	30	53	12	5	302	84	19	8
	24 Jun 93	45	23	22	9	233	91	52	4
	7 Jul 94	47	32	15	6	256	0	56	15
	22 Aug 95	37	30	21	11	276	45	57	6
	2 NOV 96	43	30	12	15	206	37	30	7
5 .>3rd Bridge (mile 1.25)	19 Sep 92	60	15	7	19	166	30	16	7
	19 Aug 93	63	12	10	15	253	30	26	5
	7 Jul 94	63	10	14	13	136	0	45	14
	30 Oct 94	53	25	15	7	177	0	20	8
	22 Aug 95	75		16	10	127	43	51	7
	2 NOV 96	67	26	7	-	170	51	25	14
6. Downstream of Diversions (mile 0.85)	19 Sep 92	19	37	dry		250 129 wet	13	6	1
	14 NOV 92					250	4	6	0.4
	24 Jun 93	55	29	9	7	210	25	90	3
	10 Sep 93	51	34	9	6	221	16	72	4
	7 Jul 94	41	36	17	6	231	0	148	9
	30 Oct 94		isolated pools			231	0	0	0
	23 Aug 95	39	36	19	6	209	26	132	3
	2 NOV 96	44	36	13	7	228	28	45	11

Table 2. Habitats sampled and estimated mean densities of coho and steelhead (fish/100 feet) on Redwood Creek in 1988 (Hofstra and Anderson 1989), 1992, 1993, 1994, 1995 and 1996.

Number of Sites	Sample Date	Habitat Types Sampled				Length Sampled	Density		
							Coho	Steelhead	
		Pol	Gld	Run	Rif	(feet)		0+	1/2+
4 sites	Oct 88					436+	5	--16---	
4 sites	Jun-Sep 92	37	40	5	7	1032	45	23	4
4 sites	Jun-Aug 93	48	25	18	9	951	46	56	4
7 sites	July 94	58	25	12	6	1287	2	69	14
5 sites	Oct 94	83	10	4	3	1018	2	34	6
4 sites	Aug 95	41	30	19	10	796	42	97	4
3 sites	NOV 96	51	31	11	7	604	39	33	11

Table 3. Number of fish handled and electroshock mortality rates for Redwood Creek on 2 November 1996.

Species	Number Captured	Number killed	% Mortality
Coho	214	2	0.9
Steelhead			
age 0+	196	0	0
age 1 +	63	0	0
Totals	473	2	0.4

Figure 1. Standard lengths of young-of-year steelhead at Site 5 (Third Bridge) and Site 3 (> Kent Canyon) in October 1994 and at Site 5 in August 1995 and November 1996.

		1994	1995	1996
40 - 44	mm	xxxxxxx		
45 - 49		xxxxxxxxxxxxxx	xx	x
50 - 54		xxxxxxx	xxxxxxxxxxx	x
55 - 59		xxxxxxxxxx	xxxxxxxxxxxxxxx	xxxxxxxxx
60 - 64		xxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxxxx
65 - 69		xxxxxxxx	xxxxxx	xxxxxx
70 - 74		x	xxxxxx	xx
75 - 79			xx	
80 - 84			xx	x
85 - 89			x	